

FORECASTING SENSORIMOTOR ADAPTABILITY FROM BASELINE INTER-TRIAL CORRELATIONS

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INTRODUCTION

One of the greatest challenges for sensorimotor adaptation to the spaceflight environment is the large variability in symptoms, and corresponding functional impairments, from one crewmember to the next. This renders preflight training and countermeasure development difficult, as a “one-size-fits-all” approach is inappropriate. Therefore, it would be highly advantageous to know ahead of time which crewmembers might have more difficulty adjusting to the novel g-levels inherent to spaceflight. This information could guide individually customized countermeasures, which would enable more efficient use of crew time and provide better outcomes. The principal aim of this work is to look for baseline performance metrics that relate to locomotor adaptability. We propose a novel hypothesis that considers baseline inter-trial correlations, the trial-to-trial fluctuations (“noise”) in motor performance, as a predictor of individual adaptive capabilities.

METHODS

Baseline inter-trial correlations: Inter-trial correlations specify the relationships among repeated trials of a given task that transpire as a consequence of correcting for previous performance errors over multiple timescales. They describe how rapidly information from past trials is “forgotten:” shorter inter-trial correlations are indicative of shorter-memory processes, while longer inter-trial correlations are indicative of longer-memory processes. One way to examine inter-trial correlations is to measure the decay of the power spectrum (PS), which yields a straight line on a log-log frequency plot that we characterize by its negative slope β . Smaller vs. larger β -values represent shorter vs. longer inter-trial correlations, respectively.

Experimental approach: Our multiphase project began with a retrospective analysis of treadmill gait-adaptation data previously collected by Dr. Bloomberg and colleagues. In that study, fourteen test subjects performed 8min of baseline treadmill walking followed by 20min of locomotor adaptability training during which they were exposed to a challenging multi-sensory environment: walking on a treadmill whose base of support oscillated in roll while fully immersed in a discordant visual flow pattern. To-date, we have quantified the strength of inter-trial correlations in the baseline step cadence data for future comparison with the locomotor adaptability performance data.

RESULTS

Baseline inter-trial correlations were computed for each of the 14 subjects. There was considerable spread among the numerical β -values across subjects. This is an important feature that baseline performance metrics must have to be viable predictors of individual adaptability. Due to the complex nature of the treadmill adaptability-training paradigm, analysis of the adaptation data is still ongoing; once the adaptability metrics are computed, they will be compared to the baseline performance metrics.

CONCLUSIONS

At the conclusion of this project we hope to uncover a baseline predictor of locomotor adaptability. If our inter-trial correlation hypothesis holds true, our results will demonstrate that the temporal structure of baseline behavioral data contains important information that may aid in forecasting adaptive capacities. The ability to predict such adaptability in the sensorimotor system has important implications for spaceflight, where astronauts must adjust their motor programs following a change in g-level to maintain movement accuracy.

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